

Risk factors for recurrent falls among Brazilian women and men: the Brazilian Osteoporosis Study (BRAZOS)

Fatores de risco para quedas recorrentes entre mulheres e homens brasileiros: o Estudo Brasileiro sobre Osteoporose (BRAZOS)

Marcelo de Medeiros Pinheiro ¹

Rozana Mesquita Ciconelli ¹

Lígia Araújo Martini ²

Marcos Bosi Ferraz ¹

Abstract

The objective of the study was to estimate the frequency of recurrent falls and identify the main associated risk factors. The BRAZOS is the first epidemiological study performed on a representative sample of the Brazilian population. Anthropometric data, living habits, previous fractures, falls, dietary intake, physical activity and quality of life were evaluated in 2,420 individuals aged 40 and older. Recurrent falls were reported by 15.5% of men and 25.6% of women. Among women, the risk factors significantly associated to recurrent falls were age, previous fracture, sedentary lifestyle, poor quality of life, diabetes mellitus and current use of benzodiazepine. In men, the risk factors were age, poor quality of life, intake of alcoholic beverages, diabetes mellitus, previous fracture and use of benzodiazepine. A greater intake of vitamin D had a protector effect on the risk of recurrent falls. These findings demonstrated the high prevalence of recurrent falls and emphasize that a multidisciplinary approach is necessary to minimize recurrent falls and their consequences, including osteoporotic fractures.

Osteoporosis; Accidental Falls; Risk Factors

Introduction

With the ageing of the population, falls have had a related impact on public health. In general, about 30% of the elderly fall every year and nearly half of these individuals fall again. However, the incidence of falls is quite varied and depends upon different aspects of the population studied, such as gender, age, genetic factors, living habits and personal history ^{1,2,3}.

In Brazil, injuries have been the second most significant cause of death. In 2003, Gawrysze-wski et al. ⁴ analyzed Brazilian National Data on 126,529 fatal injuries and 733,712 non-fatal injury hospitalizations at public hospitals. The raw injury mortality rate was 71.5/100,000 inhabitants (122.6 for male and 22 for female). For non-fatal injuries, the rate was 414.8/100,000 and unintentional injuries were predominant (88.9%). Overall, the leading cause was unintentional falls (42.6%) and fractures are the main consequence (46.7%), especially among elderly people. Mathias et al. ⁵ have also found that falls (58.3 per 100,000 female inhabitants) and pedestrian accidents (64.8 per 100,000 male inhabitants) were the most important external causes of death among the elderly. Among the 146 admissions in 1998, 45.9% were due to falls.

Falls are multi-factor events and may be related to osteoarticular or neuromuscular problems, as well as current use of medications and several concomitant diseases. The individual impact of

¹ Escola Paulista de Medicina, Universidade Federal de São Paulo, São Paulo, Brasil.

² Faculdade de Saúde Pública, Universidade de São Paulo, São Paulo, Brasil.

Correspondence

M. M. Pinheiro
Escola Paulista de Medicina,
Universidade Federal de
São Paulo.
Av. Dr. Altino Arantes 669,
apto. 105, São Paulo, SP
04042-033, Brasil.
mpinheiro@uol.com.br

each of these aspects is not yet completely clarified, but may be cumulative and increase the risk of severe or even tragic consequences in the life of an elderly person, such as cranial-encephalic trauma, hospitalization, institutionalization, fractures and death ^{6,7}.

There are few studies that have been carried out in Latin America on this issue ^{3,5} and none on a representative sample of the Brazilian population. In São Paulo, Perracini et al. ⁸ found that 31% of 1,667 elderly individuals living in a community had fallen in the previous year and 11% suffered recurrent events. The main risk factors associated with recurrent falls were the absence of a spouse, not having a reading habit, history of fractures, difficulty in performing four or more daily activities and among those whose sight is most impaired. In Rio de Janeiro, Rozenfeld et al. ⁹ demonstrated a higher prevalence (23.3% reported one fall and 14% reported two or more falls in the previous year) in 634 women elderly people who were participating in the educational, cultural and medical care activities.

Based on the high prevalence of falls and related mortality in Brazilian studies, the Brazilian Osteoporosis Study (BRAZOS) was developed. It is the first epidemiological study implemented in a representative sample of Brazilian women and men aged 40 and older with the aim of estimating the prevalence of recurrent falls and low-impact fractures as well as identifying the main associated risk factors.

Methods

From March to April 2006, 2,420 individuals (70% of them women) aged 40 and older, representative of all socioeconomic classes in 150 cities of the five regions of Brazil were assessed using a cross-sectional and quantitative survey. Individuals with different levels of education and several occupational conditions were included in the sample. The interviews were personal and held in the interviewees' home, administered face-to-face by a specialized team trained in this procedure. The sample size for the present study was calculated by probabilistic sampling in order to represent both the urban and rural Brazilian population as reported by the 2000 Brazilian National Census Bureau (IBGE; <http://www.ibge.gov.br>) and the 2003 National Household Sample Survey (PNAD 2003). The sample was selected in three phases, with control of gender, age and occupation; homes were randomly selected. Interviews were performed on weekdays and weekends both day and night in order to maximize the possibility of encountering the target popu-

lation at home. Sample distribution according to social class, education, marital status, ethnic group and geographic region mimicked official data for the Brazilian population. The data were further weighted to respect the distribution and proportionality of the overall Brazilian population. The sampling error was 2.2%, with 95% confidence intervals. Data collection instruments, as well as details about risk factors, nutrient intake, medication and concomitant diseases, that were classified according to the International Classification of Diseases, 10th revision (CID-10), were published recently ^{10,11}. Moreover, the history and circumstances of falls in the previous year, as well as aspects related directly to falls, such as household hazards (carpets, handrails, type of floor, furniture, pets, lighting), the use of gait assistance devices, type of shoes and functional tests (ability to stand up from a chair without using the arms; vision and hearing acuteness) were also investigated. Fear of falling was assessed using a visual analogue scale (0-100mm), with 0 representing no fear and 100 representing extreme fear; values over 40 were considered significant and as having an impact on the activities of daily living ¹².

Having had more than two falls in the previous year was defined as recurrent falling and considered the dependent variable for the logistic regression analysis ^{3,6,12}. Low-impact fracture was defined as that stemming from a fall from an individual's own height or less after 50 years of age.

All individuals were informed as to the objectives of the study, agreed to participate and signed terms of informed consent. The study was approved by the Institutional Research Ethics Committee at the Federal University of São Paulo/Paulista School of Medicine (UNIFESP/EPM).

Statistical analysis

The variables were analyzed descriptively. Student t test was used to compare variables to one another. Associations between variables were assessed through the chi-squared association test. The statistical models for the logistic regression analysis determined recurring falls as the dependent variable and all others as independent variables. The SPSS for Windows, version 12 (SPSS Inc., Chicago, U.S.A.) and SAS for Windows, version 8.02 (SAS Inst., Cary, U.S.A.) were used for the processing, analysis and construction of all models. The level of significance for the statistical tests was set at 5% ($p < 0.05$).

Results

Recurrent falls were reported by 15.5% of men and 25.6% of women. Table 1 shows the anthropometric characteristics of the sample according to the presence of recurrent falls and separated by gender. In both genders, individuals having experienced recurrent falls were significantly older, thinner and shorter than those who had not fallen.

Fear of falling was reported by 42.3% of men and 59.8% of women, especially those over the age of 60, as well as among individuals with a previous history of falls and those from less privileged socioeconomic classes ($p < 0.05$). Among the women, falls mainly occurred within the home (63%) during the activities of daily living ($p < 0.05$), whereas falls outside the home (65%) were more frequently reported by men. Among those who experienced falls, 15.8% had fractures as a consequence.

Men from the southern region of the country (8.6%) had less recurrent falls than those from other regions ($p < 0.05$). The same finding was observed among women, where those from the south region (14.9%) had less reports of recurrent falls than those from the other regions of the country ($p < 0.05$). Men from rural areas had a significantly higher percentage of recurrent falls compared with those from metropolitan areas (16.3 and 13.1%, respectively). However, this finding was not observed among women (24.5 and 25.5%, respectively).

Table 2 presents the clinical risk factors for falls in men and women. The diseases associated with recurrent falls were osteoporosis, diabetes mellitus, hypertension, depression, dizziness and chronic lower back pain ($p < 0.05$). Multiple childbirths exhibited a tendency towards an association with a greater risk of falls. Current exposure to sunlight, family history of hip fracture, current smoking habits, age at first men-

struation, age at menopause and current use of vitamin supplements as well as blood pressure medications were not significantly associated with recurrent falls. Epilepsy, dementia, stroke and rheumatoid arthritis were not associated with recurrent falls in either men or women. Women used significantly more benzodiazepine (10.5%), anti-vertigo (3.7%), antidepressant (12.2%) and corticosteroid (13%) medications than men (6.1%, 1.9%, 1.9% and 9%, respectively). However, men used more anti-convulsion medications (20.4% vs. 1.3%) ($p < 0.05$). All illnesses were reported more by women than by men ($p < 0.05$).

In the univariate analysis, recurrent falls among men were associated to socioeconomic variables (retired, not economically active), smoking habits, poor quality of life, sedentary lifestyle, advanced age, lower polyunsaturated fatty acids (PUFA), vitamin D and vitamin K intake (adjusted for energy), higher body mass index (BMI), associated diseases (depression, epilepsy, asthma, chronic lower back pain, arterial hypertension, diabetes mellitus, osteoporosis) and concomitant medications (tricyclic, anti-hypertensive, corticosteroids, benzodiazepine and biguanids). Table 3 displays the main risk factors for recurrent falls after the statistical adjustments for confounding variables, such as weight, BMI, ethnic background, marital status and socioeconomic aspects.

Recurrent falls among women were associated with smoking habits, sedentary lifestyle, early menopause, advanced age, lower PUFA and omega 3 intake (adjusted for energy), lower BMI, multiple childbirths, poor quality of life, associated diseases (osteoarthritis, chronic low back pain, renal lithiasis, depression, diabetes mellitus, osteoporosis) and current concomitant medications (tricyclic, anti-hypertensive, non-hormonal anti-inflammatory, corticosteroids, diuretics, benzodiazepine, anti-vertigo). Table 4 shows the

Table 1

General characteristics of the Brazilian population according to recurrent falls in the previous year.

	No falls		Recurrent faller		p-value *	p-value **
	Men (n = 613)	Women (n = 1,261)	Men (n = 112)	Women (n = 434)		
Age (years)	54.3 ± 11.3	55.2 ± 11.7	57.1 ± 11.8	57.1 ± 12.1	0.007	0.02
Weight (kg)	75.0 ± 14.4	67.8 ± 14.8	72.3 ± 14.1	65.4 ± 13.5	0.04	0.01
Height (m)	1.69 ± 0.07	1.57 ± 0.07	1.66 ± 0.06	1.56 ± 0.07	0.03	0.02
Body mass index (kg/m ²)	26.3 ± 4.5	27.7 ± 5.9	26.1 ± 4.9	26.3 ± 5.2	0.08	0.002

* p-value for comparison between male fallers and non-fallers, Student t test;

** p-value for comparison between female fallers and non-fallers, Student t test.

Table 2

Clinical risk factors for recurrent falls in the Brazilian population according to recurrent falls in the previous year.

Variable	No falls (%)		Recurrent faller (%)		p-value *	p-value **
	Men (n = 613)	Women (n = 1,261)	Men (n = 112)	Women (n = 434)		
Previous fracture	26.8	18.7	39.3	30.8	0.002	0.02
Fear of falling (VAS ≥ 40)	16.9	36.9	42.3	59.8	< 0.001	< 0.001
Use of gait assistance device	1.6	1.8	11.9	4.9	< 0.001	< 0.001
Hazards in the home						
Use of handrail	38.5	41.6	57.4	31.3	0.01	0.048
Use of anti-slip floor	34.2	29.2	36.2	25.0	0.09	0.08
Use of stairs	28.2	26.0	34.3	31.8	0.08	0.03
Use of carpets	53.2	56.4	45.5	51.5	0.06	0.07
Insufficient lighting	3.6	5.5	11.2	9.2	< 0.001	0.02
Functional tests						
Inability to stand up ***	10.5	16.8	23.1	27.9	< 0.001	< 0.001
Vision acuteness	37.0	56.0	50.4	64.9	0.002	0.003
Hearing acuteness	13.0	13.8	18.7	21.3	0.05	0.001
Concomitant medication #						
Anti-vertigo	0.4	1.4	1.5	2.3	0.32	0.31
Anti-depressant	1.2	4.0	0.7	8.2	0.35	0.004
Anti-convulsion	10.8	0.6	9.6	0.7	0.12	0.42
Benzodiazepine	0.9	3.9	5.2	6.6	< 0.001	0.04
Corticosteroid	2.3	4.1	6.7	8.9	0.009	0.002
Neuroleptic	1.9	0.9	0.7	1.0	0.21	0.28
Hormonal therapy	-	6.9	-	11.1	-	0.01
Associated diseases						
Osteoporosis	3.0	8.4	8.1	15.1	0.006	< 0.001
Osteoarthritis	4.4	7.9	3.0	12.8	0.16	0.007
Arterial hypertension	23.3	31.7	31.1	41.6	0.03	< 0.001
Diabetes mellitus	6.8	8.5	13.3	16.5	0.009	0.03
Depression	5.0	14.0	11.2	22.0	0.006	0.04
Chronic low back pain	13.6	19.8	21.5	24.9	0.01	0.03
Dizziness	20.8	40.6	38.8	51.8	< 0.001	0.004

VAS: visual analogue scale.

* p-value for comparison between male fallers and non fallers, Pearson chi-square test;

** p-value for comparison between female fallers and non fallers, Pearson chi-square test;

*** Inability to stand up from a chair without the use of the arms;

Current use.

main risk factors significantly related to recurrent falls after the statistical adjustments.

Discussion

Our results demonstrated a high frequency of recurrent falls in Brazil, especially among women, individuals aged 60 and older and those with a previous occurrence of falling. A number of studies have also found a higher prevalence of falls among women ^{1,2,8,9,13}. However, the Longitudinal Ageing Study Amsterdam (LASA) found

a similar frequency between men and women (24.4% and 24.9%, respectively) ¹².

In general, the main risk factors associated with recurrent falls are female gender, advanced age, low weight, previous falls and fractures, current use of psychotropic medication, muscle weakness, reduced gait speed, functional disability, sedentary lifestyle, fear of falling, cognitive deterioration, presence of hazards in the home, alcoholic beverage intake and diverse illnesses, such as diabetes mellitus, arthritis, depression, urinary incontinence, Parkinson's disease, dizziness and stroke ¹².

Table 3

Final logistic regression model for recurrent falls among Brazilian men.

	OR	95%CI	p-value
Advanced age	1.7	1.2-3.5	0.01
Current consumption of alcoholic beverages	2.8	1.5-4.9	0.02
Quality of life (physical aspects)	2.0	1.1-4.0	0.05
Previous fracture	4.2	1.5-11.7	< 0.001
Diabetes mellitus	1.9	1.2-5.6	0.01
Benzodiazepine (current use)	4.4	1.1-17.4	0.03
Vitamin D (daily intake adjusted for energy)	0.4	0.2-0.8	0.01

Table 4

Final logistic regression model for recurrent falls among Brazilian women.

	OR	95%CI	p-value
Advanced age	1.5	1.1-2.9	0.01
Previous fracture	2.6	1.5-4.4	0.001
Quality of life (physical aspects)	2.5	1.4-4.5	0.002
Sedentary lifestyle	1.4	1.1-3.8	0.02
Diabetes mellitus	1.8	1.2-2.7	0.02
Benzodiazepine (current use)	2.1	1.3-4.6	0.04

In the elderly, the prevalence of recurrent falls in the previous year can range from 10 to 40%. Our study assessed both genders of the general population aged 40 and older. The prevalence was similar to that found in the Study of Osteoporotic Fractures (SOF)¹⁴, LASA¹⁵ and a study carried out in southern Australia, in which 28 to 32% of individuals reported at least one fall in the previous year¹⁶. In Latin America, the prevalence of falls also exhibits considerable variation (from 21.6% in Barbados to 34% in Chile). According to data on the São Paulo population of a Latin American study, a 29% overall prevalence of falls was observed, among which 16.8% were just one fall in the last 12 months and 12.2% were recurrent^{3,6}.

The fear of falling is reported by 30 to 70% of the elderly, is more common among women, and increases with the advance in age. In our study, about 42% of men and nearly 60% of women with a history of recurrent falls reported this sensation. More than 60% of elderly individuals who have fallen develop a fear of falling and nearly 30% report functional limitations in the performance of instrumental activities of daily living and recreation. Furthermore, such individuals exhibit a loss of confidence, a greater degree of

dependence¹⁷ and 80% avoid performing activities in which there is a risk of falling¹⁸. The fear of falling is related to several psychological, social and physical conditions, especially isolation, cognitive impairment, reduced mobility and impairment in quality of life¹⁹. Multidisciplinary measures such as tai chi, exercise and the use of hip protectors may reduce the fear of falling²⁰.

Traditionally, depression, osteoarthritis, postural hypotension, dizziness, urinary incontinence and dementia are associated with a greater risk of falls^{1,3,6,12}. In the BRAZOS study, the only illness related to a greater risk of falls and fractures in men and women was diabetes mellitus, which has also been demonstrated in other studies^{3,21,22}. A number of different mechanisms are considered responsible for this finding, such as peripheral neuropathy, compromised renal function, inadequate glucose control, hypoglycemia, diabetes-related muscle weakness, impaired vision and hearing, and a change in the distribution of body composition^{23,24}. We did not study aspects related to sensory or motor peripheral neuropathy, as described by others^{24,25}.

Vitamin D deficiency is common and may increase the risk of falls among the elderly. Al-

though controversial, vitamin D supplementation may improve neuromuscular function and reduce the number of falls by 10 to 20% among elderly individuals at greater risk of falls, particularly in the winter²⁶. In the BRAZOS study, although a serum measurement of vitamin D has not been performed, we found a low mean intake of calcium and vitamin D (400mg and 2µg/day, respectively). In men, the higher dietary intake of vitamin D performed a significant protective role against the risk of recurrent falls.

This is the first epidemiological study to assess the correlation between recurrent falls and quality of life in a representative sample of the general adult population in Brazil. Recurrent falls may cause deterioration in quality of life²⁷ and the decline in quality of life may be used as a parameter to discriminate elderly individuals with recurrent falls and those who do not have this problem²⁸. Furthermore, fall prevention programs, particularly those that focus on exercise, are important strategies in reducing the risk of falls as well as improving quality of life, functional capacity, gait and balance among elderly²⁹.

The current use of benzodiazepine for either long or short durations, antidepressants (tricyclic and serotonin uptake inhibitors) and anti-convulsion medication were significantly associated with a greater risk of falls¹⁴. A number of authors have recently suggested that the chronic use of benzodiazepine should be restricted among the elderly, particularly due to the significant association with a greater risk of falls and fractures. In our study, only the chronic and current use of benzodiazepine was associated with a greater risk of falls in men and women aged 40 and older. The two-fold greater risk of recurrent falls among benzodiazepine users is similar to that described by Pariente et al.³⁰.

It is important to emphasize that the clinical risk factors for recurrent falls found in the BRAZOS study (diabetes mellitus, sedentary lifestyle, chronic use of medications, low intake of nutrients, previous fractures, poor quality of life) were associated with functional decline, disability, sarcopenia, fractures, institutionalization and death among the elderly³¹. These findings can be grouped in the phenotype of frailty syndrome. Although this syndrome has no well-defined classification criteria, a number of authors state that the presence of three or more items (unintentional weight loss, weakness, self-reported reduction in energy, low degree of physical activity and slower gait) can be used to identify frail patients, regardless of age, weight or gender^{32,33,34}. In the present study, we applied clinical frailty criteria based on self-reported data from individuals aged 65 and older, but there was only a tendency

toward an association to a greater risk of recurrent falls ($p = 0.06$). The association between the lowest tercile of energy intake (less than 21kcal/kg)³⁵ and a greater risk of falls was also not statistically significant ($p = 0.07$). There was no significant association with macro and micronutrient intake.

Without an adequate assessment of other outcomes related to falls such as physical activity, social, economic and cognitive aspects, studies on the incidence, prevalence and risk factor identification of falls do not allow an appropriate measurement of the impact of risk factors for recurrent falls. The BRAZOS study carried out a broad investigation of all these factors, including osteoporotic fractures and quality of life. However, the present study has some limitations. The responses to the questionnaires were given by individuals, although previous evidence has demonstrated adequate accuracy and reliability in this methodology¹. Moreover, no assessment of neuromuscular function and mobility was performed³⁶. In the EPIDOS (Epidémiologie de l'Ostéoporose) study, slower gait velocity and difficulty walking were among the main risk factors associated with falls and hip fractures³⁷. Besides, the combination of risk factors, bone density and falls plays an important role in the determination of the individual risk of fractures in each patient and increases the sensitivity and specificity of instruments designed to identify individuals at risk of fractures in population studies^{13,16}. Strategies for the prevention of fractures due to bone fragility should encompass all these aspects.

BRAZOS is the first epidemiological study carried out on a random, representative sample of the Brazilian population (with a large degree of ethnic, socioeconomic and cultural diversity) to assess the risk of falls and osteoporotic fractures as well as the association with quality of life, nutritional habits and physical activity. This study also included data on individuals from both small towns and large cities as well as from metropolitan and rural areas. Determining the prevalence and specific risk factors of a population is an important strategy for the implementation of education measures and health promotion. Thus, the prevention of falls in our population should begin with these data in order to draft effective preventive measures. Measures for minimizing the risk of falls can be easily implemented by a multidisciplinary team involving physicians (adequate management of illness and medication), physical educators (better neuromuscular function and encouragement of regular physical activities), nutritionists (optimizing calcium and vitamin D intake and/or supplementation) and psychologists (improvement in cognitive aspects and those related to quality of life and the fear of falling).

Resumo

Estimar a frequência de quedas recorrentes e identificar os principais fatores de risco associados. O BRAZOS é o primeiro estudo epidemiológico realizado em amostragem representativa da população brasileira. Dados antropométricos, hábitos de vida, fratura prévia, quedas, dieta, atividade física e qualidade de vida foram avaliados em 2.420 indivíduos adultos. Quedas recorrentes foram referidas por 15,5% dos homens e 25,6% das mulheres. Nas mulheres, os fatores de risco associados com quedas recorrentes foram idade, fratura prévia, sedentarismo, pior qualidade de vida, diabetes mellitus e uso atual de benzodiazepínicos. Nos homens, foram idade, pior qualidade de vida, consumo de bebidas alcoólicas, diabetes mellitus, fratura prévia e uso atual de benzodiazepínicos. Maior ingestão de vitamina D desempenhou efeito protetor sobre o risco de quedas recorrentes. Esses achados demonstram elevada prevalência de quedas recorrentes e enfatizam a necessidade de uma abordagem multidisciplinar a fim de minimizá-las bem como de suas consequências como as fraturas por osteoporose.

Osteoporose; Acidentes por Quedas; Fatores de Risco

Contributors

M. M. Pinheiro was responsible for the study design, statistical analysis and elaboration of the paper. R. M. Ciconelli was responsible for the study design and paper elaboration. L. A. Martini performed all the nutrient calculation and participated in paper elaboration. M. B. Ferraz was responsible for the study design and paper elaboration.

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